MEETING REPORT

Sixth International Conference on Nano Science and Technology*

The 6th International Conference on Nano Science and Technology (ICONSAT 2014) was held recently at Mohali. The inauguration started with the welcome notes of A. K. Ganguli (Chairperson, ICONSAT 2014 and Director, Institute of Nano Science and Technology (INST), Mohali) and A. K Grover (Vice-Chancellor, Panjab University, Chandigarh). P. Asthana (Mission Director, Nano Mission, DST) presented the road map of DST-sponsored Nano Mission and the future of nano science research in India. T. Ramasami (Secretary, DST) and C. N. R. Rao (JNCASR, Bangalore; Chairperson, Nano Mission, DST) also spoke. The four-day long conference had three plenary sessions, 17 parallel sessions and a special event 'Nano for Young'.

The first INST–Langmuir lecture was presented by C. N. R. Rao in which he talked about artificial photosynthesis to produce renewable energy by the use of sunlight. He showcased the recent results obtained from his laboratory on the photochemical generation of hydrogen by different strategies, specially those involving semiconductor heterostructures of the type ZnO/Pt/CdS[4] or nanosheets of chalcogenides such as MoS_2 and TaS_2. He explained how artificial photosynthesis, employing the modified Z-scheme of natural photosynthesis, can be exploited both for the oxidation and reduction of water.

James Heath (California Institute of Technology, USA) presented the first INST–Feynman lecture. He was one of the key researchers to discover the C_{60} molecule during his Ph D at Rice University. In his talk, Heath discussed about the complex problem of treating patients with late-stage heterogeneous tumours, such as the brain cancer glioblastoma multiforme (GBM). At the molecular level, almost no two patients look the same. Heath's presentation addressed whether pre-treatment measurements can be done to give clinically actionable insight about what drives tumour growth and what will eventually drive resistance. He then discussed about the use of microchip-based single-cell proteomics platforms to address this question. He argued that single cells are, in a thermodynamic sense, finite systems; such platforms allow us to capture fluctuations in the protein signalling networks that are required for tumour maintenance and growth. This, in turn, permits the use of thermodynamic-derived models for making predictions regarding how those tumours will respond to therapy.

In a plenary lecture Cato Laurencin (University of Connecticut Health Center, USA), a pioneer of regenerative engineering and nanotechnology, discussed his research work which bridges the lessons learned from developmental biology and stem cell science with advanced biomaterials science and novel constructs to ultimately generate de novo tissue. Novel designer polymers can provide bioactivity and physical features to direct regeneration of specific tissues, and structural cues especially over the nanoscale have enabled better control over cellular behaviour. Overall, they afford selective control of cell sensitivity, and temporal and spatial control of stimulatory cues. Advanced materials science is emerging as a driver of stem cell lineages, allowing distinct tissue types to regenerate into a single unit or organ system. Spatio-temporal control enabled by advanced biomaterials guides tissue development through the release of varying morphogens. Laurencin's research aims to build multi-level musculoskeletal systems through location-specific topographies and physico-chemical cues incorporated into a continuous phase using a combination of classical top-down tissue engineering approach with bottom-up strategies used in regenerative biology.

In another plenary lecture, Eugenia Kumacheva (University of Toronto, Canada) presented her work on plasmonic polymers. Her work draws a remarkable similarity between molecular polymerization reactions and one-dimensional self-assembly of metal (plasmonic) nanoparticles. In this approach, nanoparticles act as multifunctional monomer units (nanomers) to form reversible, noncovalent bonds at specific bond angles and organize themselves into a polymer-like chain (plasmonic polymer). The kinetics and statistics of molecular step-growth polymerization enable a quantitative prediction of the architecture of linear, branched and cyclic, self-assembled nanostructures; their aggregation numbers and polydispersity, and the formation of structural isomers. The marked similarity between molecules and nanoparticles spanning two orders of magnitude in length scales has been used to conceptualize and design hetero nanostructures analogous to molecular copolymers. The proposed strategy provides a route to exploring the properties of plasmonic polymers, in order to identify the most efficient types of plasmonic nanostructures. In addition, it offers the ability to create model systems and test assumptions made in molecular copolymerization using a new set of tools that is not available for molecular copolymerization.

A. K. Sood (IISc, Bangalore), in his plenary lecture, explained how Raman spectroscopy, time-resolved pump–probe femtosecond reflectivity and terahertz spectroscopies have played a key role in understanding the Dirac carriers and phonons in graphene. An understanding of ultrafast dynamics of photo-excited non-equilibrium Dirac carriers in graphene is important for its optoelectronic applications. He showed his recent results on optical pump–terahertz probe, time-resolved spectroscopy of single-layer pristine graphene, doped graphene and a few-layer graphene.

M. Prato (Università degli Studi di Trieste, Italy) demonstrated his work on organic functionalization of various types of nanocarbons, including carbon nanotubes (CNTs), fullerenes and graphene. The organic functionalization can offer the advantage of producing soluble and easy-to-handle CNTs. CNTs functionalized with bioactive moieties are particularly suited for targeted drug delivery as they exhibit reduced toxicity and high propensity to cross cell membranes. He demonstrated that CNTs can

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also act as active substrates for neuronal growth as they are compatible with neurons. Moreover, they play an interesting role in inter-neuron communication.

Gregory Scholes (University of Toronto) presented a plenary lecture on photosynthetic light-harvesting process. He demonstrated that how photosynthetic solar energy conversion occurs on an immense scale across the Earth, influencing our biosphere from climate to oceanic food webs. Photosynthetic light-harvesting complexes are sophisticated multi-chromophoric assemblies used to regulate and concentrate photo-excitations for delivery to reaction centres under wide-ranging incident irradiances. He described some examples of ultrafast energy transfer in photosynthetic light harvesting, including the incredible use of nominally dark, higher excited states of carotenoids to distribute excitation energy in LH2 from purple bacteria.

Umesh Waghmare (JNCASR) delivered a plenary lecture, where he explained how electrons and phonons are coupled in two-dimensional nanomaterials like graphene and metal di-chalcogenides. Using first-principal theoretical analysis it was demonstrated that such electron–phonon coupling is tunable with electric field, whenever allowed by symmetry. The tunability of the electron–phonon coupling with an in-plane electric field of MoS_2 can be useful for electro-resistive devices. Using symmetry principles and quantum mechanical calculations, he explained the origin of ferro-electricity in 2D semiconducting MoS_2, which may open up the possibilities of dipolectronic devices. He was also awarded the Nano Mission (junior) award at ICONSAT-2014.

Goutam De (CSIR-CGCRI, Kolkata) received the Nano Mission (senior) award. In his Nano Mission award lecture, De discussed recent results on surfactant-directed and host-mediated synthesis of nanomaterials. In the first approach, highly ordered mesoporous films, nanofibres and inorganic–organic hybrid films have been prepared. These films, when incorporated with metal nanoparticles (NPs), showed remarkable catalytic activity with reusability. A new F127–PVA–SiO_2 tri-constituent assembly approach has been developed to prepare electrospun SiO_2 nanofibres with highly ordered cubic pores. High amount of $Cd_{0.5}Zn_{0.5}S$: Cu QDs (Quantum Dots) can be loaded in organically modified silica (ORMOSIL) films, where the QDs retain their fundamental characteristics. These films showed tunable visible colour emission with high quantum yields.

Arindam Banerjee (IACS, Kolkata) was also given the Nano Mission (junior) award. He presented his recent results on developing fluorescent gold nanocluster containing three-component, white light-emitting system.

Apart from plenary and award lectures, ICONSAT-2014 had 17 parallel sessions in four different halls at the Panjab University campus, where 48 speakers presented their work in various fields of nano-science and nano-technology. The themes projected in ICONSAT-2014 were: (i) Nanomaterials for energy, environment, food and agriculture; (ii) Computational nanotechnology; (iii) Nanodevices/fabrication devices/magnetics and electronics; (iv) Nanocatalysis; (v) Nanotoxicology; (vi) Nanolithography/microfluidics; (vii) Sensors; (viii) Nanomedicine/biomedical applications and (ix) Optical applications. Some of the other key lectures were presented by Martin Gijs (EPFL, Switzerland), A. K. Raychaudhury (S. N. Bose National Centre for Basic Sciences, Kolkata), P. Ayyub (TIFR, Mumbai), S. Sampath (IISc), O. Spalla (CEA, France), O. Gang (Brookhaven National Lab, USA), Z. Dong (University of Science and Technology of China, Fudan, China), A. Chattopadhyay (IIT Guwahati), J. Vela (Iowa State University, USA), M. Kuno (University of Notre Dame, USA) and Pratajali Kambhampati (McGill University, Canada). Two parallel sessions were organized for industrial presentations, where various companies demonstrated their state-of-the-art systems and innovations. Three poster sessions were conducted in the conference, where 430 participants presented their research work. Top 25 posters were awarded cash prizes, which were sponsored by the Royal Society of Chemistry. Also, five outstanding posters were honored with 'INST–CNR Rao Poster Award for Excellence in Research'. Each of the above carried a certificate and a cash prize.

A special event 'Nano for Young' was organized to introduce young minds of this region to the enormous potential and exciting phenomena in the nanoscale regime which exist in nature. Around 800 students from various institutions in Chandigarh and neighbouring parts of Punjab and Haryana attended this unique interactive session comprising multimedia presentations and short talks. T. Pradeep (IITM, Chennai), D. D. Sarma (IISc), G. Kulkarni (JNCASR) and K. N. Ganesh (IISER, Pune) showcased the wonder of nanoscience and nanotechnology to the young generation. C. S. Sundar (IGCAR, Kalpakkam) chaired this session.

The closing keynote lecture was presented by Ashok Ganguli, where he spoke about recent results of his group on the understanding of the mechanics of droplet interaction which controls the shape and size of nanostructures during microemulsions-mediated synthesis. He explained the application of fluorescence correlation spectroscopy and small-angle X-ray scattering studies to understand the droplet fusion.

As chairperson of the conference Ashok Ganguli extended his thanks and greetings to all participants, delegates, sponsors, organizing committee members and student volunteers for making the event a grand success.

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